THE CAROLINA BAT

Flittermouse and His Family and Relatives.

AN ANIMAL WITHOUT ANCESTORS.

The Bat Had No Prototype, but Has Been a Bat from the Beginning—The Great Winged Animals of Ages Past Were Like the Bats That We Know—The Five Families of Bats—The Far-famed Vampires and What They Really Be—Stories of Bats by Naturalists Who Know Them.

This little brown bat has been selected as our type of all bats because it is the one only animal of the kind found in both the Old World and the New. It has, indeed, a very wide range, being found in America from Lake Winnipeg to Guatemala, while in the old world it extends from England to Siberia and even to India and the Camaroon Mountains of Africa. It is common in all the Atlantic States and abounds in Albany during February and March, as De Kay tells us in his "Natural History of New York." No other kind of bat whatever is found on both sides of the Atlantic.

"But who cares for a bat?" may be the exclamation of more than one of my readers, and indeed such small animals as the bats of temperate regions, animals so very rarely seen by day, all of which appear at the first glance so much alike, may seem to most persons to be objects of little interest.

CAROLINA BAT.

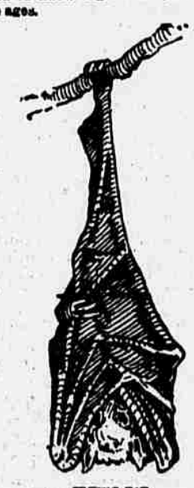
I must then ask to be taken on trust when I affirm that all bats are exceedingly interesting animals, a fact I hope to make evident in the present article. And the best way to make this evident will be to enable my readers to answer intelligently the simple question, "What is a bat?"

No one who has ever taken a bat in his hand and has noticed its fur, its ears, and its teeth can doubt but that it is a little beast. That the ancient Germans as well as our English-speaking ancestors saw the truth so far is evident from the names they respectively bestowed on it—from the German name, *fledermaus* and the old English term, *flittermouse*.

Nevertheless bats were very often supposed to be birds. Such seems to have been the opinion of the Jews, and the "bird of darkness" is placed in Deut. xiv., 18, among the unclean ones forbidden as food:

And the stork and the heron after her kind, and the lapwing and the bat.

Aristotle, though he placed the bats among flying animals, and therefore among birds, recognized distinctly the difference in their organization, and the same thing may be affirmed of Pliny. But in spite of this, and although Albertus Magnus, in the thirteenth century, was acquainted fully with the true nature of bats as being beasts, as also with their habit of hibernating during the cold season, we find that instead of progress a retrogression in knowledge took place after the middle ages.



FLYING FOX.

Thus Belon in 1557, in his "Histoire de la Nature des Oiseaux," includes bats with his birds. At the same time he was not unacquainted with the mode of their reproduction, as the following verse proves:

La souris chauve est un oiseau de nuict
Qui point ne pond; ains ses petits enfante
Lesquels de laict de ses tetins suntante
En petit corps grande vertu reluit.

Again, almost a hundred later on—in 1645—Aldrovandus expressed his conviction that bats were rather birds than beasts, and this in spite of his careful study of them, as proved by his beginning to distinguish different species one from another.

About a quarter of a century afterward, Ray assigned them their true place, which they have kept ever since.

But though the bat is a beast, it is a very peculiar one, and is essentially an animal of the air. All its structure is modified for flight, and it rarely descends to the ground.

In studying the turkey we saw how all a bird's structure is also modified for flight, but the modifications of bats and birds, though directed to the same end, are, as we shall see, very different modifications. Indeed the bat's organization, alone of existing creatures, serves to give us a good conception of certain extinct reptiles, namely, of those ancient flying forms (pterodactyls) of the age of reptiles to which I have referred several times in these articles and especially to that on the bullfrog. The real affinities well serve to show how little mere external aspect can be trusted as a guide to fundamental relationships. The bat, as I have just said, is essentially an animal formed

COMMON BAT—AMERICA.

for aerial life above the surface of the ground. The mole is an animal formed for subterranean life beneath that surface, and the mole as rarely ascends to that surface as the bat descends to it, and all its structure is so efficiently modified for most rapid burrowing that it may be said to fly through the earth as the bat flies through the air. The bat's hand, as we shall see, attains the maximum of length and slenderness, while the mole's is at a minimum of length, but is a model of concentrated power. The contrast between any animals could hardly be more complete; yet the bat and the mole share no small degree of affinity and may be said to be zoological cousins.

And now let us take a somewhat close look at our chosen typical form, the Carolina bat. It has a little rounded body about two and a half inches long, covered with a very soft fur, which Shakespeare calls "wool" when enumerating the ingredients of Macbeth's Witches' cauldron. It has a small head with very small eyes, but large ears. It has a slender tail, nearly two inches long, and two pairs of limbs, extremely different both in size and structure. Its legs are of but moderate length, but disposed so singularly that the knees are bent almost backward, like our elbows.

COMMON BATS—ENGLAND.

Each leg ends in a foot with five toes, which are free (not "webbed" like those of a duck), with five claws of about the same size.

The other pair of limbs, the arms, are elongated both above and below the elbow, but the fingers are wonderfully long, and they are joined together to their tips by skin, being "webbed" like the toes of a water fowl. But it is not only the fingers which are thus "webbed." A large expanse of skin connects them with the sides of the body, and with the legs as far as the ankles, and does not even stop there, but extends onward to the tail, which is thus connected with the two legs.

The large expanse of skin which unites the fingers and extends to the sides of the body and legs is (with its component bones, &c.) called "the wing." The part between the legs is termed the "interfemoral membrane."

If we look carefully we shall see that though the four fingers of each hand are thus bound together and support the wing membrane as the "ribs" of an umbrella support its web, each thumb is nevertheless free. Each thumb indeed stands out at a wide angle and is furnished with a very long, strong and hooked claw.

The ear seems at the first glance to be a double organ, a very small one appearing inside the larger one. This appearance, however, is due merely to the very large development of that small prominence which in ourselves projects backward, to cover eternally and so to guard the opening of the ear. This small body is called the "tragus."

When treating of the opossum I have spoken of flying opossum and flying squirrels, but none of these creatures, any more than the flying fish or any existing reptiles, really "flies."

The bat, however, flies as truly as the bird does, and in the same way—by striking the air with its fore limbs, but the mechanism is very different. In my article about the turkey I noted how in birds the bones of the hand are reduced to a minimum, the fingers being both diminished in number and greatly shortened. From the brief description of the bat's wing just given we may see that in it the very opposite condition obtains.

A similar condition obtained in those ancient flying reptiles, the pterodactyles, inasmuch as they flew by means of a wing membrane sustained by the elongated bones of the hand. Nevertheless, in those reptiles it was only one finger which was thus elongated. Thus here again the similarity of their wing with that of the bat must have arisen independently.

Did no such creatures as bats now exist we should have a much less perfect notion than we now possess of what the flight of the ancient pterodactyles must have been. But another independent similarity of structure, one which must have arisen at least four times over, may be noted with respect to organs which subserve the movements of the wings.

When treating of birds, we noted their almost universally "keeled" breast bone, which, by the fact of its being keeled, affords sufficient scope for the implantation of the powerful muscles which act on the wings. Bats also require powerful muscles of the kind, and on that account have also developed a keel on their breast bone. The same was the case with the ancient pterodactyles, and such is the case, also, with the bat's subterranean cousin, the mole, which also requires most powerful muscles to move its short limbs, which by the extreme rapidity and power of their strokes enable the creatures, as I have said before, to "fly" through the soil.

The wings being thus true organs of flight, the legs and tail together exercise a rudder-like action.

Any one who has watched the flight of bats must have been struck with the extremely rapid turns they repeatedly make—movements necessary to enable them to seize their insect food. As before said, they rarely descend to the ground, but when they do so they can crawl upon it, though in so doing they have a singularly awkward and shuffling gait. Their wings are then closed (the long fingers lying side by side) and the animal rests on its wrists and hind feet, the body being dragged forward by the help of the strong hooked thumb nails, which also help it to climb with ease up any rough surface, even though perpendicular.

LEAFED-NOSED BAT.

When at rest bats usually hang suspended, head downward, by the claws of their feet, though occasionally they turn round and hang by the claws of their thumbs.

Most nocturnal beasts have large eyes, but almost all bats have very small ones. This is perhaps due to the fact that bats seem in their flight to be guided by an extraordinarily delicate sense of touch, as was long ago experimentally demonstrated by Spallanzani. He (not having any fear of anti-vivisectionists before his eyes) found that bats deprived of the power of sight, and as far as possible of smell and hearing also, were still able not only to avoid ordinary obstacles to their flight in places quite new to them, but even to pass without contact between threads which purposely had been extended in various directions across the room in which the experiments were made. This sense is believed to be due to an exceedingly delicate power of sensation possessed by the membrane of the wing—a power enabling the creature to feel by atmospheric pressure and vibration the nearness of adjacent objects.

Certainly if the wing does possess such sensibility the great extent of its surface must intensify it to a high degree. Now, the wing is richly supplied with nerves, while the power of feeling in nerves depends greatly on the amount of blood supplied to them. This we all know by the numbness we can bring easily on in any one of our fingers by tying a string tightly round its root, which causes it, as we say, to "go to sleep," a condition occasioned by depriving its nerves of their due supply of blood. The circulation of that fluid in man and beasts is brought about mainly by the rhythmical contractions of the heart, while this is aided by the elasticity of the arteries, which, though not themselves contractile, have a power, through their elasticity, of propelling the blood which is not passed by the veins.

Now, it is a very remarkable fact that the late Dr. Wharton Jones found that the veins in the bat's wing were positively contractile, thus serving in a most exceptional manner to propel the blood, and so, indirectly, augment such powers of sensation as the delicate membrane of the bat's wing may be supplied with.

There are probably not less than a thousand different species of bats, for most likely the species already collected do not amount to half those which will be eventually known to us. No less than four hundred species were fully described a dozen years ago by Mr. G. A. Dobson, a naturalist who has especially devoted himself to the study of these animals.

Bats form an order of beasts primarily divided into two groups, or sections, very unequal in size. One of these comprises every kind of bat found in America, from the extreme north—the confines of the Arctic circle—to Cape Horn, and all those of Europe and Asia and north of Palestine.

The other group contains only the flying foxes and their allies, of which not more than about eighty species are yet known, none of which is found in America.

No bats of any kind are found where neither insects nor fruit can be obtained.

Thus there are none in Iceland nor in Kerguelan Land. They are found in most oceanic islands, even the small Savage Island, southeast of the Navigator's group, being inhabited by one kind of flying fox.

None appears, however, to inhabit the islands of the Low Archipelago or in the Galapagos group, nor has any been found in St. Helena.

That great primary division to which the Carolina bats and all American and European bats belong is made up of five subordinate groups, or families, as follows: (1) The common bats family, (2) the leaf-nosed bats family, (3) the Old World blood-sucking family, (4) the oblique-snouted family, and (5) the New World blood-sucking family.*

I will notice first the family of common bats, whereof more than twelve dozen different species have been already described. Though only one of these species, the Carolina bat, is common to both the Old World and the New, yet the family, as a whole, is common to both, while it ranges from 32 degrees north latitude down to Terra del Fuego.

BLOOD SUCKERS.

About a dozen species of the family are found in England. The commonest of these is the pipistrelle, which is also found throughout the whole of the northern regions of the Old World, including northern Africa. It is the first to make its appearance in England in the spring. Bats, like dormice, when winter approaches fall into a peculiar state of winter sleep called hibernation. For this purpose they generally assemble together in large numbers, in out-of-the-way places, caverns, hollow trees, the inside of church towers, or within the roofs of outhouses, hanging head downward by the claws of their feet. During this condition the most important functions of life—breathing and the circulation of the blood—go on very slowly indeed, while the temperature of the body becomes notably diminished. From this dormant condition the pipistrelle usually rouses itself by the middle of March or soon after, and has been known even to shake off its slumbers and flit about in the middle of a bright, sunny but frosty day just before Christmas.

Its food consists specially of gnats, and as those animals often dance in the sunbeams of a winter's day in England, it is easy to understand that this little bat may then go after them. But it will eat various other insects and even flesh, and it has been caught in a larder while making a hearty meal from a piece of meat to which it was clinging.

VAMPIRE.

In confinement it has also been observed to strike down a fly with its wings and then prostrate itself over it, stretching out all its membranes to prevent the fly's escape, while it thrust down its head between its arms and secured it.

Most bats, save flying foxes, are well fitted for such food, as their grinding teeth bristle with sharp points most excellently fitted to crack the hard but brittle case which encloses an insect's body.

The flight of the pipistrelle is quick and flitting, and it is often to be seen in the neighborhood of ponds or streams in search of its favorite food.

Its cry is exceedingly shrill, so much so that some persons are quite unable to hear it.

Homer compares the voices of the ghosts to the cries of bats. In the 24th book of the Odyssey, 6, he says: "As when bats in a corner of a quiet cave, when one of them has fallen from off the cluster—so they (the ghosts) went along screaming."

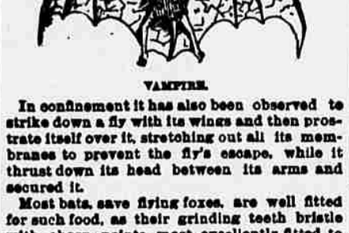
As Pope gives it:

Trembling the spectres glide, and plaintive vent
Their hollow screams along the deep descent.
As in the cavern of some rifled den,
When flock nocturnal bats, and birds obscene
Clustered they hang, till as some sudden shock
They move, and murmurs run through all the rock,
So cowering fled the sable host of ghosts.

Bats bring forth one or two young ones at a birth. They are born naked and blind, and are suckled much as is the human infant.

Years ago a Mr. Daniell recorded his observations on this subject with respect to a female noctule bat, which is one of the largest species found in England. She was kept in a cage, wherein one day her owner observed that she was very restless.

The uneasiness continued for upward of an hour, the animal remaining in her usual attitude, suspended by her hind feet. On a sudden she reversed her position, and attached herself by her anterior limbs to a cross wire of the cage, stretching her hind legs to their utmost extent, curving the tail upward, and expanding the interfemoral membrane so as to form a perfect nest-like cavity for the reception of the young. Into this receptacle it was born, lying on its back, perfectly destitute of hair, blind, and larger than a new-born mouse. Its hind legs and claws were remarkably strong and serviceable, enabling it not only to cling to its mother, but also to the dead sides of the cage. The dam held her baby wrapped up in the membrane of her wing, shifting it occasionally from side to side to suckle it.



EVENING BAT.

Curious bats named long-eared bats are found both in England and the United States, though not the same species. The American species ranges from Vancouver's Island to Alabama and Florida.

These bats well deserve their name, for their ears are so long that they equal in length the entire trunk. They are, therefore, relatively larger than those of any other animal. They are capable of being folded up, and generally are so folded during sleep.

Speaking of this little animal, Mr. Bell tells us (British Quadrupeds, page 56):

It is one of the most common British bats, and the extraordinary development of the ears, their beautiful transparency, and the elegant curves into which they are thrown at the will of the animal, render it by far the most pleasing. It is also more readily tamed than any other, and may soon be brought to exhibit a considerable degree of familiarity with those who feed and caress it. I have frequently watched them when in confinement, and have observed them to be bold and familiar even from the first. They are very cleanly, not only cleaning themselves after feeding, and at other times, with great assiduity, but occasionally assisting each other in this office. They are very playful, too, and their gambols are not the less amusing from their awkwardness. They run over and against each other, pretending to bite, but never harming their companions of the same species, though I have seen them exhibit a sad spirit of persecution to an unfortunate barbastelle bat which was placed in the same cage with them. They may readily be brought to eat from the hand; and my friend, Mr. James Sowerby, had one during last summer which when at liberty in the parlor would fly to the hand of any of the young people who held up a fly toward it, and, pitching on the hand, take the fly without hesitation. If the insect were held between the lips, the bat would then settle on its young patron's cheek and take the fly with great gentleness from the mouth; and so far was this familiarity carried that when either of my young friends made a humming noise with the mouth in imitation of an insect, the bat would search about the lips for the promised dainty.

RED BAT.

One of the "young friends" here referred to is now the esteemed Secretary of the Royal Botanic Society of London, and he has assured me of the truth of this anecdote.

The barbastelle bat is a kind confined to the northern regions of the Old World. It is a small bat with swollen cheeks and short ears, each containing a tragus more than half as long as the ear itself.

One found asleep in a chalk cavern in England began to wake up when brought into a warm room, when it fed readily on small bits of meat and drank water. It was fond of lying on the hearth rug before the fire, appearing to luxuriate on the warmth. It was, however, a timid animal, not at all disposed to become familiar in the way that long-eared bats will so become.

The leaf-nosed bats (2) form a family confined to the temperate and tropical parts of the Old World from Old Ireland to New Ireland. In temperate regions they hibernate in dry and warm hiding places during the winter, not venturing abroad while any cold remains. In tropical and sub-tropical countries they frequent hill regions, and many kinds are clothed with very long and dense fur. More than fifty species have been described.

These bats are very remarkable for the extraordinary folds and processes of skin which surround and decorate their noses, which appear to be excessively delicate organs of touch, no doubt capable of appreciating the proximity of objects through atmospheric pressure in an extremely high degree. This would appear to be the case both on account of the large nerves with which these organs are supplied, and also from the fact that when leaf-nosed bats are observed flying with common bats in an enclosed space they much excel the latter in dexterity.

The nose leaf consists of three parts: (1) A more or less horseshoe-shaped fold of skin which invests the sides and front of the muzzle and includes the nostrils within its inner margin; (2) A central ridge-like process between and behind the nostrils, and (3) a membrane behind this, which either stands up vertically or extends backwards between the ears, which differ from those of the common bats, in that no sort of second ear—the tragus—stands up within them.

These bats come out later at night than the common bats, and they have especially pointed teeth to crush the dense cases of beetles on which they feed largely.

When they are plentiful some species of this family live for a great part in the year in troops counting several hundreds each and inhabiting great caverns.

When the pairing time is over the females separate from the males and carry on their maternal duties in permanent "mothers' meetings." The males carry on a club life by themselves till their spouses have sent off the little ones, who can soon take care of themselves. Thereupon society life is again resumed. This cannot be said to be a universal custom, however, for one of the largest Indian species seem usually to dwell in pairs. This kind is also remarkable for being less nocturnal than most of its congeners, as it commences its flight early in the evening and generally careers about not more than thirty feet above the ground. It seems, indeed, that it is the smaller species of insect feeding bats which fly high, seeking small insects there to be found, while the larger bats hawk about below after the large beetles and other large insects which the smaller bats could not manage, which hover about among the branches of trees.

When these leaf-nosed bats are disturbed the curious membranes on their noses are kept in constant motion, while the head is turned about in all directions as if thus to discover the cause of the disturbance.

The third family of bats I have distinguished as Old World bloodsuckers, but do not by this mean to imply that the dozen species it contains all have the habit of sucking blood, but only that one typical form called Megaderma has it.

REDDISH-GRAY BAT.

That well known Indian observer, the late Mr. Blyth, actually captured a specimen in the act of sucking the blood, while flying, from a smaller bat which it afterward devoured. His statement is as follows (Journal of the Asiatic Society of Bengal, vol xi.):

Chancing one evening to observe a rather large bat enter an outhouse, from which there was no other egress than by the doorway, I was fortunate in being able to procure a light, and thus to proceed to the capture of the animal. Upon finding itself pursued it took three or four turns round the apartment, when down dropped what at the moment I supposed to be its young, which I deposited in my handkerchief. After a somewhat tedious chase, I then secured the object of my pursuit, which proved to be a fine female Megaderma. I then looked to the other bat which I had picked up, and to my considerable surprise found it to be a small kind of pipistrella, which is exceedingly abundant throughout India. The individual now referred to was feeble from loss of blood, which it was evident the Megaderma had been sucking from a large and still bleeding wound under and behind the ear; and the very obviously suctional form of the mouth of the Megaderma was itself sufficient to hint the strong probability of such being the case. During the very short time that elapsed before I entered the outhouse, it did not appear that the depredator had once alighted; and I am satisfied that it sucked the vital fluid from its victim as it flew, having probably seized it on the wing, and that it was seeking a quiet nook, where it might devour the body at leisure. I kept both animals separate till next morning, when, procuring a convenient cage, I first put in the Megaderma, and after observing it for some time, I placed the pipistrelle with it. No sooner was the latter perceived than the other fastened upon it with the ferocity of a tiger, again seizing it behind the ear, and made several efforts to fly off with it; but finding it must needs stay within the precincts of the cage, it soon hung by the hind legs to one side of its prison, and after sucking its victim till no more blood was left, commenced devouring it, and soon left nothing but the head and some portions of the limbs.

The members of this small family are confined exclusively to the warmer parts of Africa and Asia, from Egypt to Celebes. They have a very conspicuous nose leaf and large ears, medially united to each other above the head, and each with a large tragus within.

The oblique-snouted family of bats (4) is very large, sixty-three species having been already described a dozen years ago. It has representatives in both hemispheres.

Seven genera (with thirteen species) are peculiar to America, five are peculiar to the New World, while two are common to both.

These bats have no nose leaves, and the faces of some of them remind us of pug dogs.

The tail projects freely beyond the short interfemoral membrane. Many of them have narrow wings and some are very naked.

The most curious form (Cheiromeles) from the Malay region has a very thick skin, almost naked, while its great toe is very large and separated from the others, reminding us of those of a monkey. A curious fold of skin on the breast and sides of the body serves as a cradle for the baby. Such nursing pouches are probably absolutely necessary for the preservation of the young, which otherwise could scarcely maintain its hold on the naked body of the mother during flight.

Mr. Dobson has remarked truly that it is interesting to find these pouches developed in both the male and the female, for their presence in the former suggests the idea that, where the young are born together, the male may relieve the female of one of them. That such may indeed be the case is made probable by an analogous habit which exists in some flying foxes, we shall presently see.

The fifth and last family of the larger primary section of the order of bats is that which I have distinguished as the New World bloodsuckers. It indeed is confined exclusively to South and Central America, save one species which is said to extend up to Bermuda and South Carolina.

There are from sixty to seventy species, among which the renowned vampires are included. All of them possess nose leaves, but, unlike the Old World nose-leaved bats, they also have a well-developed tragus within the ears, and also rather larger eyes.

It appears that only one or two of the family are really bloodsuckers, and those kinds which in science are specially distinguished as vampires appear to be insect-eating bats.

LONG-HAIRED BAT.

All sorts of exaggerated accounts were given, although some old observations which some discredited are now found to have been justified.

D'Azara affirmed that they would sometimes bite the wattles and crests of fowls while asleep, and suck their blood. The fowls, he said, generally die of this, as gangrene is engendered by the wounds. He adds:

They bite also horses, mules, asses, and horned cattle, usually on the shoulders, buttocks, or neck, as they are better enabled to arrive at those parts, from the facilities afforded them by the mane and tail. Nor is man himself secure from their attacks. On this point I am able to give a very faithful testimony, since I have had the ends of my toes bitten by them four times while I was sleeping in the cottages in the open country. The wounds which they inflicted, without my feeling them at the time, were circular, or rather elliptical.

The late Mr. Darwin was fortunate enough to be able not only conclusively to prove the truth of this blood-sucking habit, but also to capture an individual in the act, and to make sure exactly what species it was. It is that known as "Desmodus," a form which ranges from Mexico to Chili.

Speaking of horses, Mr. Darwin tells us ("Voyage of H. M. S. Beagle," vol. i., p. 22) that this animal

is often the cause of much trouble by biting horses on their withers. The injury is generally not so much owing to the loss of blood as to the inflammation which the pressure of the saddle afterward produces. The whole circumstance has lately been doubted in England; I was, therefore, fortunate in being present when one was actually caught on a horse's back. We were bivouacking late one evening near Coquimbo, in Chili, when my servant, noticing that one of the horses was very restive, went to see what was the matter, and fancying he could distinguish something, suddenly put his hand on the beast's withers and secured the bat. In the morning the spot where the bite had been inflicted was easily distinguished from being slightly swollen and bloody. The third day afterward we rode the horse without any ill effects.

SILVER-HAIRED BAT.

The structure of this bat is wonderfully modified in harmony with its habits. The special modifications are of two kinds—first, the form of the teeth; and, secondly, that of the stomach.

I have already called attention to the fact that the back teeth of most bats bristle with sharp points. They are also proportionately of good size, while the front, or cutting teeth, are very small indeed. In this bat, however, the back teeth are reduced to a minimum both in size and number, being quite rudimentary, at the same time the two middle cutting teeth of the upper jaw are of good size and provided with sharp cutting edges, like lancets.

They are thus admirably fitted to make the small puncture which the animal requires to be able to make in order that it may obtain its needful nourishment.

The stomach presents us with a structure quite unique in the animal kingdom. The stomachs of most bats yet noticed are more or less rounded structures, not extending far either right or left from the spot where the gullet enters into it. It is the part on the left of the gullet's entrance which is the more digestive portion in animals, and it is sometimes much enlarged and subdivided.

The part on the right of the gullet is large in such creatures as sheep and oxen, and it receives the fresh-cropped herbage before digestion begins. In this curious bat the left, or more digestive part of the stomach is reduced to a mere rudiment—the highly nutritious food (blood) requiring very little digestion. A capacious cavity is, however, needed for its reception, and, accordingly, the part of the stomach on the right of the gullet is not dilated into a mere capacious sack, as in the sheep, but is drawn out into an enormously long and wide tube capable of containing a large quantity of fluid. So greedy, however, is this bat that it will continue to suck blood after its capacious intestines are entirely filled with it, the blood first drawn escaping from the latter while fresh blood is being sucked in by the mouth.

HORSESHOE BAT.

It is now time to notice the other great primary section of the order of bats—namely, the flying foxes.

Of these, as before said, about eighty species are known, none of them being American. They range from Asia Minor and Egypt through Africa and Asia to Australia, the Fiji, and Duke of York's, and Navigators' Islands and New Ireland. None are found in Tasmania or New Zealand. Among these are found the largest of all bats. The body may be a foot long and the outstretched wings measure five feet across. They are also the most brightly colored and the most varied in tint. Only in one species is there a long tail; in all the others it is short or may be entirely absent. The first finger of the wing generally bears a claw. These bats feed on fruit and not on insects, and therefore their teeth, instead of bristling with sharp points, are smooth save that they each bear a bilophidinal furrow.

The stomach is not rounded, as in most bats, but elongated. Its elongation, however, is just the opposite of that of the blood-sucking desmodus, and it is the left in his digestive portion of the organ which is elongated.

The largest of these bats is that known as the kalong. It inhabits the Indian Archipelago, extending from the Andaman and Nicobar Islands to the Philippines and Timor.

In the lower parts of Java it is very common and lives in troops which do not appear to visit the more elevated districts.

Numerous individuals select a tange tree for their resort, and suspending themselves by the claws of their hind limbs to the naked branches, often in companies of several hundreds, afford to a stranger a very singular spectacle. A species of fig tree often found near the villages of the natives affords them a favorable retreat, and the extended branches of one of these are sometimes covered with them. They pass the greater part of the day in sleep, hanging motionless, ranged in succes-

BARBASTELLE.

sion with the head downward, the wing membrane contracted about the body, and often in close contact they have little resemblance to living beings, and by a person not accustomed to their economy are mistaken readily for part of a tree, or for a fruit of uncommon size suspended from its branches. In general these societies preserve a perfect silence during the day, but if they are disturbed, or if a contention arises among them, they emit sharp piercing shrieks, and their awkward attempts to extricate themselves when oppressed by the light of the sun exhibit a ludicrous spectacle. In consequence of the sharpness of their claws, their attachment is so strong that they cannot readily leave their hold without the assistance of their wings. If suddenly killed in their natural attitude during the day, they still continue suspended after death. It is necessary, therefore, to oblige them to take wing by alarming them if it be desired to obtain them during the day. Soon after sunset they gradually quit their hold, and pursue their nocturnal flight in quest of food. They direct their course by an unerring instinct to the forests, villages, and plantations, occasioning incalculable mischief, attacking and devouring indiscriminately every kind of fruit, from the abundant and useful wood nut, which surrounds the dwellings of the meanest peasantry, to the rare and most delicate productions which are cultivated with care by princes and chiefs. By the latter as well as by the European colonists various methods are employed to protect the orchards and gardens. Without such precaution but little valuable fruit would escape the ravages of the kalong. They may be observed as soon as the light of the sun is gone. Then the bats may be seen to follow each other at small but irregular distances, and this succession continues till darkness obstructs the view. The flight of the kalong is slow and steady, pursued in a straight line, and capable of long continuance. The hunting of these bats forms occasionally an amusement during the moonlight nights. Each is watched till it descends on a fruit tree, and then a discharge of small shot will bring it to the ground. Four or five specimens may thus be obtained in an hour.

Most of the flying foxes inhabit trees, but some also are found in caverns with various other species of bats.

Mr. Pryor (a corresponding member of the Zoological Society of London) had a curious experience respecting bats in caves when he explored the caverns of North Borneo which are inhabited by the swift, which make the edible nest so much prized by the Chinese. He tells in Proceedings of the Zoological Society 1884, p. 534:

After a rest I ascended the cliff about 400 feet. The ascent is quite perpendicular. In many places ladders are erected, and in others the water-worn surface of the limestone gives a foothold. On the ascent I noticed many orchids, begonias, ferns and mosses I had not seen elsewhere. My collector caught a snake I believe to be an *Elaphis*, certainly the most beautiful Colubrine I have seen, white and light gray. The Malays said it was very destructive to the swifts, and also that it was poisonous; to convince them it was not, I allowed it to bite me. At this point I found myself at the mouth of a cave named Simnd Putih, &c., the White Cave. The entrance is about 40 feet high by 60 feet wide, and descends very steeply, widening out to a great size and having a perpendicular unexplored abyss at its furthest point. This cave is used by the nest gatherers as their dwelling place, and at the entrance are their platforms of sticks, one of which was placed at my disposal by the head man; it is also the cave by which the great body of the swifts enter. Immediately outside it is a great circular opening leading sheer down into Simnd Itam; this is one of the two openings mentioned as giving light to that cave, and is the entrance most in use by the bats. As soon as I had unpacked and settled down on my platform I sallied out to find the material from which the birds make their nests, as my previous experience is that birds do not as a rule travel far for the bulk of the material they use. I was speedily successful in my search. It is a fungoid growth which incrusts the rock in damp places, and when fresh resembles half-melted gum tragacanth; outside it is brown but inside white, and little if any change in its consistency is effected by the bird; the inside of the nest is, however, formed by threads of the same substance, which are drawn out of the mouth in a similar way to that of a caterpillar weaving its cocoon.

KALONG.

The Malays told me to be sure and return to Simnd Putih at 5 o'clock, as I should then see the most wonderful sight in all Borneo—the departure of the bats and the return to roost of the swifts. I accordingly took a seat on a block of limestone at the mouth of the cave; the surface of the coral of which it is composed is quite fresh looking, notwithstanding that it must have been many ages in its present position, several hundred feet above sea level. Soon I heard a rushing sound, and, peering over the edge of the circular opening leading into Simnd Itam, I saw columns of bats wheeling round the sides in regular order. Shortly after 5 o'clock, although the sun had not yet set, the columns began to rise above the edge, still in a circular flight; they then rose, wheeling round a high tree growing on the opposite side, and every few minutes a large flight would break off, and, after rising high in the air, disappear in the distance; each flight contained many thousands. I counted nineteen flocks go off in this way, and they continued to go off in a continual stream until it was too dark for me to see them any longer. Among them were three albinos, called by the Malays the Rajah, his son and wife.

At a quarter to 6 the swifts began to come in to Simnd Putih. A few had been flying in and out all day long, but now they began to pour in, at first in tens and then in hundreds, until the sound of their wings was like a strong gale of wind whistling through the rigging of a ship. They continued flying in until after midnight, as I could still see them flashing by over my head when I went to sleep. As long as it remained light I found it impossible to catch any with my butterfly net, but after dark it was only necessary to wave the net in the air to secure as many as I wanted. Nevertheless they must undoubtedly possess wonderful powers of sight to fly about in the dark in the deepest recesses of their caves and to return to their nests, often built in places where no light ever penetrates.

Shortly before sundown a pair of kites made their appearance, and, taking their station over the bat chasm, would every now and then sweep down into the thick of the bats, generally securing a victim every time. I shot both these marauders, which proved to be "*Haliastur indus*," a very beautiful but common bird. There were also several specimens of a hawk working away on the bats in a very business-like manner, and woe betide the unfortunate bat singled out from its flock and put in chase! The way these hawks took the bats one after the other was astonishing, and strongly reminded me of a man eating oysters. I shot several of these hawks, but only secured one, the others being lost over the side of the cliff. It proved to be the rare *Machærhamphus alcinus*, remarkable for the size of its gape and its small beak, both of which very much resemble those of the swifts. Its habits in taking its prey are also similar, the swift catching and swallowing its food while on the wing in the same way as this hawk does.

Arising before daylight, I witnessed a reversal of the proceedings of the previous night, the swifts now going out of Simnd Putih and the bats going into Simnd Itam. The latter literally "rained" into their chasm for two hours after daylight. On looking up the air seemed filled with small specks, which flashed down perpendicularly with great rapidity and disappeared in the darkness below. * * * I secured many specimens of the bat and found them to be all of one species. The wings are very long and narrow, and it is a very swift flyer. I noticed a few specimens of a swallow and also some very large bats at the mouth of the cave. These large bats were, of course, some kind of flying foxes.

I have now said my say about all the kinds of bats which inhabit the world in our day; but we know little indeed of bats which inhabited it in earlier epochs. The oldest known remains are but fossils found in tertiary deposits and they offer us no sterling revelation.

Some form of existing beasts which are now distinct enough (such as the ox, the pig, and the horse) were preceded in early tertiary times by others which were more or less intermediate in structure. This is not the case as regards bats. Bats, as soon as they appear at all, appear as thoroughly and as perfectly organized as are those bats living among us now. And living bats are separated from all other beasts in a very marked manner. They constitute an order by themselves, and this fact, together with the various others we have been able to set down, will, I think, enable the reader to answer the question, "What is a bat?" in a reasonable manner.

But the question how bats came to be, what was the origin of the bat, we are by no means able to answer. We cannot say what creatures may have been the bat's predecessors or at what epoch the bat first appeared save that it was before the deposition of the tertiary rocks.

There is one animal, found in Singapore and Borneo, which has been supposed to show some affinity to bats. This is the colugo, or, as it is sometimes called, the flying lemur.

FLYING LEMUR.

It has its fingers webbed, while a membrane extends on either side between the arms and the legs, and from the legs to the tail. So far it is like a bat, but its fingers are not elongated and its toes are webbed, while those of the bat are not. Moreover, though it takes long jumps through the air and may be able somewhat to guide its flight, it certainly does not truly fly. We cannot therefore regard this animal as exhibiting any indication of the source of the bat tribe.

We must, it seems, wait as patiently as may be for more light from the stores of yet undiscovered fossils which the earth contains.

Considering what has been the source of the most wonderful treasures of the kind lately discovered, it is not to the Old World but to the New we must look hopefully, to those wonder-revealing strata which have been so fortunately discovered and industriously explored within the far-reaching, and happily even further-reaching, area of the United States.

ST. GEORGE MIVART.

* These five families are known in science respectively by the names: (1) Vespertilionida, (2) Rhinolophida, (3) Mystacina, (4) Rhinolophurida, and (5) Phyllostomida.